Dec. 14, 1965 J. W. CANNON 3,223,957

THREE-DIMENSIONAL PLUGBOARD CIRCUIT SELECTOR

Filed July 22, 1963

FIG. 1.

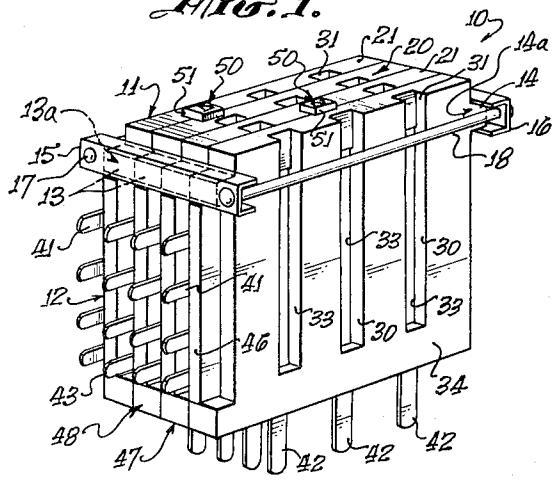


FIG. 2.

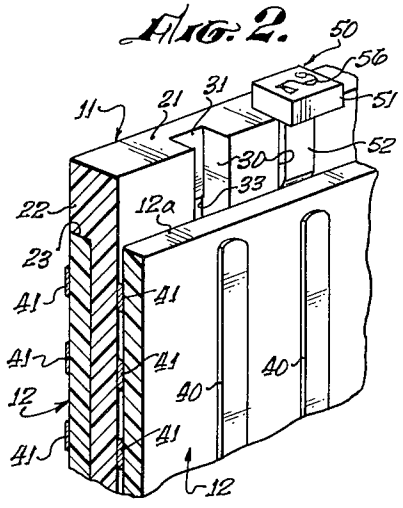


FIG. 3.

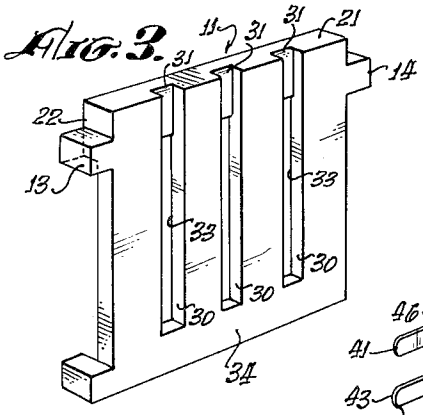


FIG. 4.

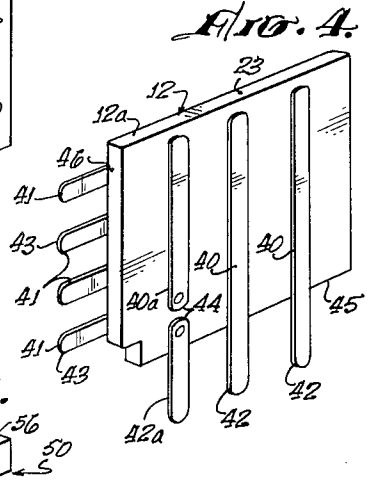


FIG. 5.

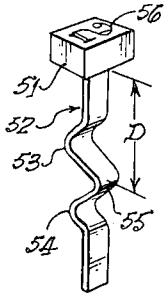
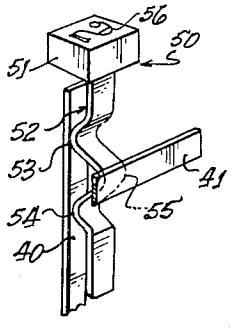


FIG. 6.



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United States Patent Office 3,223,957 Patented Dec. 14, 1965

3,223,957

THREE-DIMENSIONAL PLUGBOARD CIRCUIT SELECTOR

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Filed July 22, 1963, Ser. No. 296,684
5 Claims. (Cl. 339—18)

This invention relates generally to a plugboard circuit selector, and more particularly, to a three-dimensional plugboard in the form of a laminated block structure comprised of alternate circuit boards and spacer boards, and novel plug means of assorted lengths for interconnecting selected circuit elements on the adjacent surfaces of a pair of circuit boards lying on opposite sides of the same spacer board.

The rapid expansion of complex electronic circuit devices in industrial and military applications has brought with it a demand for circuit structures which can be easily revised by manual plug-in means. The old fashioned circuit chassis with a completely soldered wire circuit has proven completely inadequate, since changes are frequently required, and hours of tedious work by skilled personnel would be required to trace circuits through wiring and rewire by the traditional methods.

A forerunner of modern plug-in systems was the old and familiar manual telephone switchboard, with its retractable plugs, and interconnecting plug lines.

In modern electronic circuitry, a great variety of plug-in systems have been employed. For example, a complex circuit has been subdivided into a large number of components, each wired separately on its own card, and then all cards plugged into some type of card-holding box or other structure.

However, almost all of these previously known devices continue to be either too complex or too bulky for circuits in which it is desirable to have a great variety of possible alternative connections available, where connection is to be made by a relatively unskilled person without any knowledge or understanding of the internal construction of the circuit. In such applications, it is much preferred that interconnection be achieved by plug-in means of simple construction and free of any wiring which might be tangled or broken.

Moreover, the plug-in circuit card is too complex and fragile a device to be placed in the hands of unskilled personnel, and further more is an entirely unnecessary expense in many important applications.

Wire-less plug-in means heretofore known have generally presented only a very limited choice of circuit interconnections. Interconnecting plug-in jacks have generally followed the designs of pre-transistor technology, and are not well suited to achieving selection of a variety of circuit connections at one and the same jack receptacle.

It would be extremely advantageous in both experimental work and in the limited production characteristic of complex electronic computer and control devices to have a plugboard circuit selector comprised almost exclusively of standard components. The engineering department could then quickly fabricate a variety of experimental "bread-board" models which would closely simulate the ultimate product in size and structure. Heretofore, however, "bread-board" circuit means have generally been of a space-consuming and fragile structure completely unsuited for use in an end product.

It is the major object of the present invention to provide a plugboard circuit selector constructed of standard circuit board and spacer board parts, and offering a great variety of possible interconnections along X, Y, and Z axes.

It is another object to achieve the advantages of the invention by means of a plug structure in which the plugs are extremely simple in construction and are readily distinguishable, one from the other, by visual inspection by unskilled personnel.

Still another important object of the invention is to provide a three-dimensional plugboard circuit selector suitable both for experimental and production use, but of extremely rugged and compact construction.

Still another important object of the invention is to provide a plugboard circuit selector in which the circuit boards are readily adapted to use with transistor and other solid-state circuits. For example, it is an important advantage of the present invention that the circuit boards may be readily disassembled from the selector, and revisions made in any of the semiconductor elements thereon. Furthermore, the selector is so constructed that terminal edges of each circuit board are supported outboard of the main block structure, so that relatively bulky circuit elements (up to the thickness of the spacer boards) may be mounted on said exposed terminal edges.

The foregoing and other advantages of the invention may be understood from the following description of one preferred specific embodiment, read in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a three-dimensional plug board circuit selector constructed according to my invention;

FIGURE 2 is a perspective view showing, fragmentarily, one spacer board and the two circuit boards on each side thereof, and also, one plug-in means, shown inserted into interconnecting position;

FIGURE 3 is a perspective view of a spacer board of the type used in the construction of FIGURE 1;

FIGURE 4 is a circuit board of the type used in the construction of FIGURE 1;

FIGURE 5 is a typical interconnecting plug suitable for use with the construction illustrated in FIGURE 1; and

FIGURE 6 is a perspective view showing the manner in which adjacent connector strips, on circuit boards on opposite sides of a spacer board, are interconnected by the insertion of the plug means of FIGURE 5.

In FIGURE 1 the numeral **10** is used to indicate generally the three-dimensional plugboard circuit selector.

It will be seen that the circuit selector **10** is in the form of a laminated block structure comprised of alternate spacer boards **11** and circuit boards **12**, which are seen in greater detail in FIGURES 3 and 4, respectively.

The laminated structure of circuit selector **10** may be held firmly in assembled condition by any suitable means. In the specific embodiment illustrated, each of the spacers **11** is provided with an oppositely disposed pair of edge shoulders **13** and **14**, which, in the assembly illustrated in FIGURE 1, provide continuous side shoulders **13***a* and **14***a*. A pair of channel members **15** and **16** fit over shoulders **13***a* and **14***a*, respectively, and are held in position by a pair of tie bars **17** and **18**.

The circuit selector **10** is seen to have the shape of a six sided rectangular parallelepiped, with a front plug-in face **20**, which is comprised entirely of contiguous por-

tions of the upper, or plug-in, edges **21** of the spacer members **11**. It will be seen from the sectional portion of the fragmentary perspective view of FIGURE 2 that the plug-in edges **21** are provided along one side with a shoulder **22**, which overhangs and encloses the upper or plug-in edge **23** of the adjacent circuit board **12**. Thus, at the plug-in face **20**, circuit boards **12** are entirely concealed behind a continuous surface formed of contiguous portions **21** of the spaced boards **11**.

The spacer boards **11** are provided with a plurality of vertical slots **30**, having upper end openings **31** in the plug-in face **20**. These slots serve as the plug receptacles for the plugboard circuit selector **10**.

The perspective view of FIGURE 3 reveals that the slots **30** provide vertically extended apertures **33**, whose opposite openings face on adjacent circuit boards **12**, and make it possible to interconnect adjacent faces of the circuit boards **12** by means of a plug-in interconnection means described hereinafter. Note, however, that the spacer board slots **30** are closed at their lower ends, so that shoulder **22** at the upper edge of spacer board **11**, and the continuous lower edge **34**, form a rigid board structure.

The circuit boards **12** are constructed as illustrated in FIGURE 4, being comprised of an insulating board panel **12***a*, which is provided with a plurality of vertical connector strips **40** on one face, and a plurality of horizontal connector strips **41** on the opposite face.

It will be understood that both the spacer boards **11** and the circuit board panels **12***a* are made up of insulating material. Connector strips **40** and **41**, however, are electrically conductive. They may be printed circuit, inlays, laminates exposed by etching, or any structure by means of which electrically conductive connector strips **40** and **41** are exposed on an otherwise non-conducting panel **12***a*.

Without any restriction on the utility of the invention, but solely for purposes of discussion and identification and description, the vertical connector strips will be hereinafter referred to as X connector strips, and the horizontal connector strips **41** as Y connector strips, since such terms suggest X and Y co-ordinate locations in a plane parellel to circuit board **12**.

It will be noted also, that each of the X and Y connector strips **40** and **41** is provided with a terminal member such as **42** for the X connector strips, and **43** for the Y connector strips, which extend beyond the edges of the circuit board panel **12***a*. Terminals **42** and **43** may be mere extensions of the connector strips **40** and **41**, or may be specially mounted strips of copper, or may actually be entirely separate and apart from the connector strip as indicated for the X connector strip **40***a* and terminal **42***a*. In usch a case, some interconnecting device would be used to connect their adjacent ends at **44**. For example, there are applications in which an isolation diode might be inserted at this point.

It will be noted from FIGURE 2 that there is an X connector strip **40** aligned with each of the spacer board slots **30**, so that one side of each of said slots **30** has a connector strip extending along substantially its entire length.

On the other hand, the Y connector strips extend transversely of the slots **30** so that the aperture **33** on the side of slot **30** opposite that in which an X connector strip **40** is located, is crossed at vertically spaced intervals by a series of horizontal Y connector strips **41**.

For purposes of convenient labeling, the edge of each circuit board **12** upon which the X terminals **42** are located may be described as the X terminal edge **45**, and the vertical edge at which the Y terminals **43** are located may be identified as the Y terminal edge **46**.

Correspondingly, the face of circuit selector **10** opposite the plug-in face **20**, namely, bottom face **47** may be identified as the X terminal face of circuit selector **10**, and the side face **48**, at which the Y terminals are located, may be identified as the Y terminal face of the circuit selector **10**.

It will be noted that the X and Y terminal edges **45** and **46** of the circuit boards **12** project a substantial distance beyond the edges of the spacer boards **11** at the X and Y terminal faces **47** and **48**. This provides a convenient space for accommodating leads attached to the terminals **42** and **43**, and for circuit items mounted at the location **44** as previously described.

FIGURE 5 is a perspective illustration of a typical plug interconnector **50**, which is seen to be comprised of a cubical stop and handle member **51** and a substantially vertically extended strip of resilient brass or copper, or the like, **52**.

The entire strip **52** can be inserted into one of the slots **30**, but stop member **51** is larger in cross section than the open end **31** of slot **30**, so that, at maximum insertion of plug interconnector **50**, stop member **51** seats on plug-in surface **20** as illustrated in FIGURES 1 and 2.

As plug interconnector **50** is inserted, a double contact is made with the adjacent X connector strips **40** by means of a pair of sliding contacts **53** and **54**. These contacts make electrical contact with X connector strips **40** regardless of the length of strip **52**, or the degree of insertion.

However, when the plug interconnector **50** is fully inserted, it makes contact with only one Y connector strip, contact being made by means of the Y contact point **55**. Just which Y connector strip will be contacted is determined by the distance indicated by the letter D. For convenience, the Y connector strip is identified on the exposed face of stop member **51** by a numeral as indicated at **56**.

In FIGURE 6, the circuit board panels **12***a* and the spacer board **11** have been eliminated in order to show in perspective the manner in which the plug interconnector **50** places an X connector strip **40** in electrical connection with a selected Y connector strip **43**.

It will be seen from the foregoing description that, relative to the plug-in face **20**, X co-ordinates may be considered as measured at spaced intervals along the upper edges of the circuit boards **12**, whereas Y co-ordinates correspond to the distance downwardly behind the plug-in surface **20**. Z co-ordinates may be considered as measured horizontally normal to the circuit boards **12**.

By suitable insertion of plug interconnectors **50**, and connections from the terminals **42** and **43** to suitable inputs, outputs, and to each other, a great variety of interconnecting arrangements may be achieved. Moreover, the circuit boards **12** need not be simply insulating panels **12***a* and conductive connector strips **40** and **41**, but may include various circuit elements, especially at the terminal edges **45** and **46**, and not all of these be alike for every circuit board **12**.

The finished product can be made to provide a great number of circuit rearrangements which may be produced simply by the insertion of various numbered plug interconnectors **50**, which may be inserted by unskilled personnel pursuant to private instructions of a simple kind.

It will be understood that the preferred specific embodiment described is but one of many possible versions of the invention. It is not my intention to be restricted to the details as illustrated in the drawings, but to comprehend all variations and departures therefrom, which fall within the spirit of the invention as defined in the following claims.

For example, the embodiment of FIGURE 1 shows a circuit selector with only three X co-ordinate values and only five Y co-ordinate values, and only four circuit boards **12**. It will be obvious that many decimal digital applications will call for ten circuit boards **12**, each bearing ten X connector strips **40** and ten Y connector strips **41**. Likewise, in such an embodiment, the spacer boards **11** will have ten slots **30**.

Also, it will be evident that the construction of the plug-in means **50** has many advantages, particularly because of the resilience of the strip **52**, which permits sliding insertion of the strip **52**, while resiliently urging the contact points **53**, **54**, and **55** into appropriate contact as indicated in FIGURE 6. However it will be obvious that it would be easy to present equivalent construction for spacer boards **11**, circuit boards **12**, and plug interconnectors **50**, as well as various means for holding the entire laminated structure in assembly as indicated in FIGURE 1.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A plugboard circuit selector which includes: a laminated block structure comprised of an assembly in alternate arrangement of circuit boards and spacer boards, said block structure having X and Y terminal faces at right angles to said boards and to one another, and a plug-in face on the opposite side of said block structure from said X terminal face; walls in said spacer boards defining plug-in slots longitudinally normal to said plug-in face, each of said slots having an open end at said plug-in face; a plurality of parallel X connector strips, said strips being disposed at said slots in longitudinal alignment therewith and extending to terminal locations at said X terminal edges; a plurality of parallel Y connector strips, said Y connector strips being disposed transversely to said slots and said X connector strips and extending to terminal locations at said Y terminal edges; and plug interconnector means of assorted lengths adapted to be inserted into said slots at said plug-in face and interconnect a selected X connector strip with a selected Y connector strip.

2. A plugboard circuit selector which includes: a laminated block structure comprised of an assembly in alternate arrangement of circuit boards and spacer boards, said block structure having X and Y terminal faces at right angles to said boards and to one another, and a plug-in face on the opposite side of said block structure from said X terminal face; X and Y terminal edges on said circuit boards; walls in said spacer boards defining plug-in slots longitudinally normal to said plug-in face, each of said slots having an open end at said plug-in face; a plurality of parallel X connector strips on one face of each said circuit boards, said strips being disposed at said slots in longitudinal alignment therewith and extending to terminal locations at said X terminal edges; a plurality of parallel Y connector strips on each of said circuit boards, on a face opposite to that bearing said X terminal strips, said Y connector strips being disposed transversely to said slots and said X connector strips and extending to terminal locations at said Y terminal edges; and plug interconnector means of assorted lengths adapted to be inserted into said slots at said plug-in face and interconnect a selected X connector strip with a selected Y connector strip on an adjacent circuit board.

3. A plugboard circuit selector which includes: a laminated block structure comprised of an assembly in alternate arrangement of circuit boards and spacer boards, said block structure having X and Y terminal faces at right angles to said boards and to one another, and a plug-in face on the opposite side of said block structure from said X terminal face; X and Y terminal edges on said circuit boards; walls in said spacer boards defining plug-in slots longitudinally normal to said plug-in face, each of said slots having an open end at said plug-in face and a closed end at said X terminal face, and each slot providing open communication, over at least part of its length, between the adjacent faces of circuit boards on each side of said spacer board; a plurality of parallel X connector strips on one face of each said circuit boards, said strips being disposed at said slots in longitudinal alignment therewith and extending to terminal locations at said X terminal edges; a plurality of parallel Y connector strips on each of said circuit boards, on a face opposite to that bearing said X terminal strips, said Y connector strips being disposed transversely to said slots and said X connector strips and extending to terminal locations at said Y terminal edges; and plug interconnector means of assorted lengths adapted to be inserted into said slots at said plug-in face and interconnect a selected X connector strip with a selected Y connector strip on an adjacent circuit board, each said plug means comprising a locating stop adapted to seat on said plug-in face, and sliding X and Y contacts on opposite sides for electrical connections between an X connector strip and a selected one of the Y connector strips communicating with the same slot.

4. A plugboard circuit selector which includes: a laminated block structure comprised of an assembly in alternate arrangement of circuit boards and spacer boards, said block structure having X and Y terminal faces at right angles to said boards and to one another, and a plug-in face on the opposite side of said block structure from said X terminal face; X and Y terminal edges on said circuit boards, said edges projecting outwardly beyond the edges of said spacer boards at said X and Y terminal faces respectively; walls in said spacer boards defining plug-in slots longitudinally normal to said plug-in face, each of said slots having an open end at said plug-in face and a closed end at said X terminal face, and each slot providing open communication, over at least part of its length, between the adjacent faces of circuit boards on each side of said spacer board; a plurality of parallel X connector strips on one face of each said circuit boards, said strips being disposed at said slots in longitudinal alignment therewith and extending to terminal locations at said X terminal edges; a plurality of parallel Y connector strips on each of said circuit boards, on a face opposite to that bearing said X terminal strips, said Y connector strips being disposed transversely to said slots and said X connector strips and extending to terminal locations at said Y terminal edges; and plug interconnector means of assorted lengths adapted to be inserted into said slots at said plug-in face and interconnect a selected X connector strip with a selected Y connector strip on an adjacent circuit board, each said plug means comprising a locating stop adapted to seat on said plug-in face, and sliding X and Y contacts on opposite sides for electrical connections between an X connector strip and a selected one of the Y connector strips communicating with the same slot.

5. A plugboard circuit selector which includes: a laminated block structure comprised of an assembly in alternate arrangement of circuit boards and spacer boards, said block structure having X and Y terminal faces at right angles to said boards and to one another, and a plug-in face on the opposite side of said block structure from said X terminal face; X and Y terminal edges on said circuit boards, said edges projecting outwardly beyond the edges of said spacer boards at said X and Y terminal faces respectively; contiguous shoulders on the plug-in face edges of said spacer boards, said shoulders covering the plug-in face edges of said circuit boards to present a plug-in face comprised entirely of contiguous portions of said spacer boards; walls in said spacer boards defining plug-in slots longitudinally normal to said plug-in face, each of said slots having an open end at said plug-in face and a closed end at said X terminal face, and each slot providing open communication, over at least part of its length, between the adjacent faces of circuit boards on each side of said spacer board; a plurality of parallel X connector strips on one face of each said circuit boards, said strips being disposed at said slots in longitudinal alignment therewith and extending to terminal locations at said terminal edges; a plurality of parallel Y connector strips on each of said circuit boards, on a face opposite to that bearing said X terminal strips, said Y connector strips being disposed transversely

to said slots and said X connector strips and extending to terminal locations at said Y terminal edges; and plug interconnector means of assorted lengths adapted to be inserted into said slots at said plug-in face and interconnect a selected X connector strip with a selected Y connector strip on an adjacent circuit board, each said plug means comprising a locating stop adapted to seat on said plug-in face, sliding X and Y contacts on opposite sides for electrical connections between an X connector strip and a selected one of the Y connector strips communicating with the same slot, and resilient means

for urging said X and Y contacts into contact with circuit board faces and connector strips thereon adjacent a slot into which said plug interconnector means is inserted.

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